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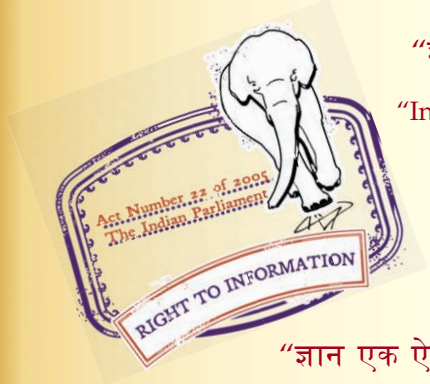
IS 6919 (1973): Method for determination of wool fibres diameter by air-flow method [TXD 1: Physical Methods of Tests]



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IS : 6919 - 1973
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Indian Standard

METHOD FOR DETERMINATION OF WOOL FIBRE DIAMETER BY AIRFLOW METHOD

UDC 677·31 : 677·017·224·3

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110001

August 1973

Indian Standard

METHOD FOR DETERMINATION OF WOOL FIBRE DIAMETER BY AIRFLOW METHOD

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Indian Standard

METHOD FOR DETERMINATION OF WOOL FIBRE DIAMETER BY AIRFLOW METHOD

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 5 March 1973, after the draft finalized by the Physical Methods of Test Sectional Committee had been approved by the Textile Division Council.

0.2 There is a close correlation between the air permeability of a uniformly arranged mass of textile fibres and the specific area (area/volume). For fibres of circular or near circular cross section and constant density, such as unmedullated wool fibres, the surface area of a given mass of fibres is inversely proportional to the average fibre diameter. This relationship is, therefore, used for determining the wool fibre diameter using airflow instruments. Owing to the speed and simplicity of the method, it is particularly suitable for quality control in the mills.

0.3 This standard is based on ISO Recommendation No. 1245 'Air permeability method for measuring the mean diameter of wool fibres' issued by the International Organization for Standardization.

0.4 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

---

1. SCOPE

1.1 This standard prescribes a method for determining the mean diameter of wool fibres using airflow instruments.

1.2 This method is applicable to clean unmedullated wool fibres dispersed in a uniform open state. It is particularly suitable for combed slivers. The method is also applicable to oil combed slivers without cleaning, if the oil content is constant and the apparatus suitably calibrated. It is not applicable to samples containing medullated fibres and fibres which are hetrogeneous in diameter.

*Rules for rounding off numerical values (*revised*).

2. PRINCIPLE

2.1 A specified mass of fibres to be tested is compressed to a constant volume in a cylindrical chamber with perforated ends to which a flowmeter and a manometer are connected. The fibres are packed in such a way that they lie predominantly at right angles to the axis of the chamber. A regulated current of air is then passed through the compressed fibres and the average fibre diameter read off from a scale on the manometer or the flowmeter.

3. APPARATUS

3.1 Airflow Apparatus — Any of the two alternative forms of apparatus, namely, 'Constant Flow' and 'Constant Pressure' as described below may be used. Both forms of apparatus have the same arrangement of parts, as illustrated in Fig. 1:

a) *Constant Flow Apparatus* — utilizes a specimen mass of 1·5 g, the flowmeter is adjusted to a fixed value and the mean fibre diameter is read off from the manometer scale. The scale is not linear since the successive intervals, corresponding to one micrometre (micron) decrease with the diameter.

b) *Constant Pressure Apparatus* — utilizes a specimen mass of 2·5 g, the manometer is adjusted to a fixed pressure and the mean fibre diameter is read off from the flowmeter. In practice this apparatus has been found to be somewhat more useful for routine work.

3.2 The apparatus consists of the following parts as shown in Fig. 1.

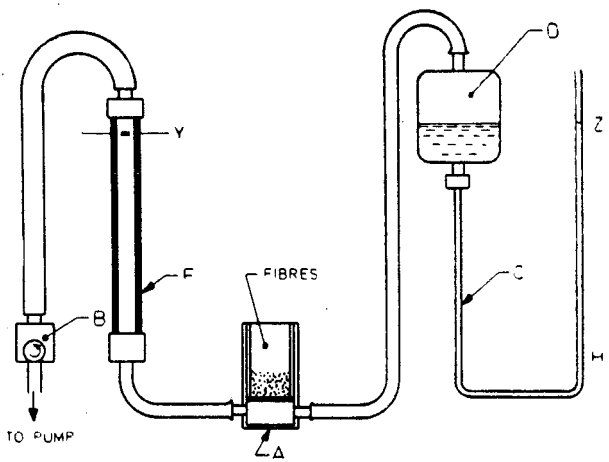


FIG. 1 GENERAL ARRANGEMENT OF APPARATUS

3.2.1 *Air Valve* (*B*) — giving sufficiently fine control of the air supply, such that the level of the flowmeter or manometer may be quickly adjusted to the working value.

3.2.2 *Suction Pump* — of a type providing a smooth output of at least 30 l/min at 200 mm head of water with minimal fluctuation of the float of the flowmeter. A filter to trap any loose fibres may be inserted between the pump and the air valve (*B*).

3.2.3 *Constant Volume Chamber* (*A*) — of brass, hardened steel, or any other suitable metal, suggested dimensions of which are given in Fig. 2. This comprises three parts, namely, (a) the base into which the fibres are packed, (b) the plunger which compresses the fibres, and (c) the screw cap which clamps the plunger to the base. The finish shall be smooth so that the plunger slides easily into the base without trapping fibres.

3.2.3.1 *Non-rotating plunger* — Rotation of the plunger is possible whilst the screw cap is being screwed on to the constant volume chamber and this can affect results. To prevent this, a thin plate of steel is fixed to the top of the plunger as shown in Fig. 3. This plate is held by the operator whilst the cap is screwed on, thus preventing rotation.

3.2.4 *Reservoir* (*D*) — of fluid manometer as specified in Table 1 mounted at sufficient height to give a clear working distance $\mathcal{Z}H$ of 350 mm in the glass limb of the manometer.

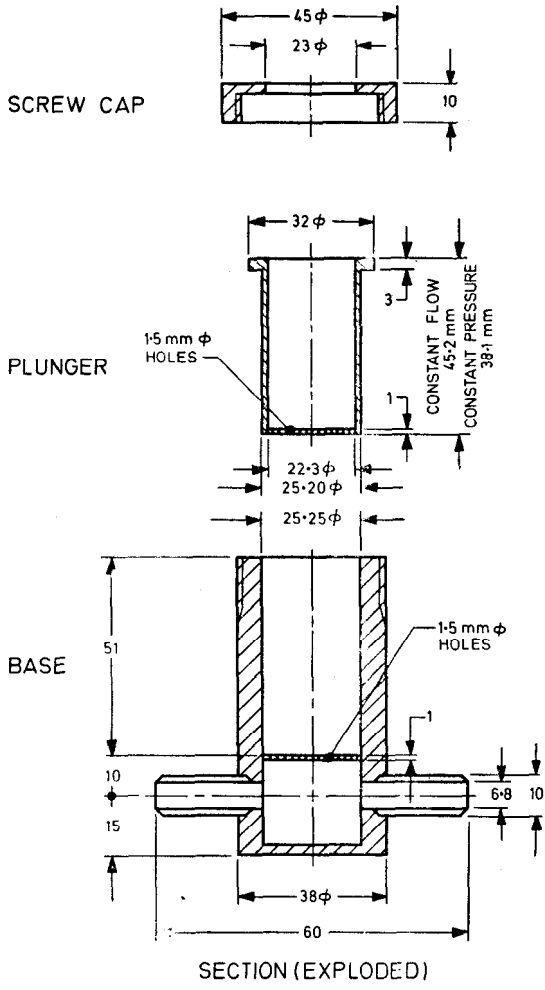
TABLE 1 MANOMETER AND FLOWMETER CHARACTERISTICS

Characteristic Considered	Constant Flow	Constant Pressure
Minimum diameter of reservoir	150 mm	60 mm
Type of manometer fluid	*n*-propyl alcohol	Distilled water
Working range of flowmeter	10 to 20 l/min	5 to 25 l/min

3.2.4.1 The manometer (*C*) is made of glass tube of internal diameter at least 5 mm to reduce surface tension effects. In both cases a small amount of dye may be added to the manometer fluid, and where this consists of distilled water, a small trace of chromic acid shall be added to give a clear meniscus. A millimetre scale is fixed behind the limb $\mathcal{Z}H$.

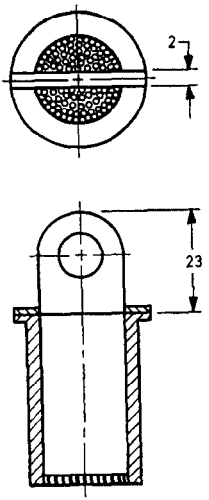
3.2.5 *Flowmeter* (*F*) — having the characteristics indicated in Table 1.

3.2.6 *Rubber Tube* — connecting the manometer reservoir (*D*) to the chamber (*A*), which shall be pressure tubing of small internal diameter to avoid constriction at the bends.



All dimensions in millimetres.

FIG. 2 SUGGESTED DIMENSIONS OF CONSTANT VOLUME CHAMBER



All dimensions in millimetres.

FIG. 3 NON-ROTATING PLUNGER

3.2.7 *Rubber or a Plastic Tube* — from the chamber (*A*), to the flowmeter (*F*), which shall be of internal diameter not less than 6 mm, shall be as short as possible and shall not be twisted or kinked between calibration of the apparatus and its subsequent use.

3.2.8 *Packing Rod* — For packing the fibres in the constant volume chamber (*see* Appendix D).

3.3 Balance — capable of weighing the specimen to an accuracy of ± 2 mg for the constant flow method and of ± 4 mg for the constant pressure method.

4. SAMPLING

4.1 Samples of wool fibres shall be drawn from the lot in such a way as to be representative of the lot. Samples drawn in compliance with the material specification or as agreed to between the buyer and the seller shall be taken as representative of the lot.

5. ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

5.1 Prior to test, the fibres shall be conditioned to moisture equilibrium and tested in standard atmospheric conditions of 65 ± 2 percent relative

humidity and 27 ± 2°C temperature as laid down in IS : 6359-1971*.

5.2 If tests are not carried out in the standard atmosphere for testing, condition the laboratory sample to moisture equilibrium near the apparatus and note the relative humidity of the atmosphere at the time of test, then correct the final results by the factors given in Appendix B.

5.3 The readings of flowmeters are influenced to a small extent by variations in barometer pressure and temperature. Correction plugs (*see* **A-3.4**) may be used if the variations in barometric pressure and temperature are appreciable at the place of testing.

6. PREPARATION OF TEST SPECIMENS

6.1 Cleaning — The laboratory sample shall be about 8 g and shall first be degreased by rinsing well in the baths each of about 200 ml of petroleum ether before conditioning. If the laboratory sample is known to be dry-combed with fatty matter content below 1 percent, the test specimens may be taken from it without cleaning. If the laboratory sample is known to be oily with fatty matter content between 3 and 4 percent, the test specimens may be taken from it without cleaning provided the apparatus has been calibrated from oil-combed slivers.

6.2 Number of Specimens — Unless otherwise specified, test a minimum of two specimens for fibre diameter below 30 microns and a minimum of three specimens for fibre diameter above 30 microns.

6.3 Selection of Specimens — Take the specimens from different places in the laboratory sample. In the case of balls of silver, the laboratory sample should be made up of pieces of silver from both inside and outside of the ball.

6.4 Specimen Mass — For the constant flow method the specimen mass should be 1·5 g ± 2 mg. For the constant pressure method the specimen mass should be 2·5 g ± 4 mg.

6.5 Preparation — For slivers with cut ends, cut off with scissors a length to give as nearly as possible the specimen mass, then make up to the exact mass by adding shorter cut lengths or portions. For slivers with pulled ends, remove and discard about five hand draws, then weigh out the specimens by taking several successive hand draws.

7. PROCEDURE

7.1 Ensure that the meniscus of the manometer is at the zero mark and, if required, carry out an orifice plate check as given in **A-3.3.**

*Method of conditioning of textiles.

7.2 Pull out the weighed test specimen into a long thin sliver and feed it evenly into the constant volume chamber (*A*), packing the fibres down with the packing rod from time to time. Insert the plunger and screw down the cap to the furthermost extent so that the lip of the plunger is in contact with the base.

7.3 Depending on the method to be used, adjust the air valve as follows:

a) For constant flow method adjust the air valve until the top of the float of the flowmeter coincides with the reference mark *Y* and note the fluid level of the manometer to the nearest millimetre or 0·1 micron (*see* **A-3.1**).

b) For constant pressure method adjust the air valve until the fluid level of the manometer coincides with the 18 cm reference mark *H* and note the position of the float of the flowmeter to the nearest millimetre or 0·1 micron (*see* **A-3.2**).

7.4 Remove the specimen from the constant volume chamber, tease out the fibres by hand, repack in the constant volume chamber without loss of fibres, insert the plunger and screw down the cap, and note the reading again as before.

7.5 Repeat the operation **7.4** so that a total of three readings on each test specimen is obtained.

7.6 Similarly test the other test specimens as given above.

8. CALCULATIONS

8.1 Calculate the average of the three readings for each specimen and then average of the readings for all test specimens and express the result to the nearest 0·1 micron.

9. REPORT

9.1 The report shall include the following information:

a) Type of material,

b) Name of the apparatus used,

c) Number of test specimens tested,

d) Whether the specimen was tested after cleaning or without cleaning,

e) Average fibre diameter, and

f) Whether tested in standard atmosphere or correction applied for relative humidity.

APPENDIX A

(*Clauses* 5.3, 7.1 *and* 7.3)

CALIBRATION OF APPARATUS

A-1. LEAKAGE TEST

A-1.1 After assembling the apparatus as in Fig. 1 remove the cap and plunger from the constant volume chamber (*A*) and insert a rubber stopper. By means of a Hoffman clip close the rubber tube between (*A*) and (*F*) after introducing a pressure difference causing the meniscus in the manometer to alter by about 15 cm. Note the position of the meniscus periodically for several minutes and if it changes, the apparatus should be examined for leaks.

A-2. SAMPLES OF SLIVERS

A-2.1 Obtain sufficient quantities of the reference slivers (*see* Appendix C) for calibration. In requesting these state:

a) the test specimen mass for the apparatus to be used (1·5 or 2·5 g), and

b) whether oil-combed or dry-combed samples are required.

Each type of sliver normally supplied is sufficient for four specimens.

A-3. GRADUATING THE SCALE

A-3.1 Constant Flow Apparatus — Make a horizontal mark *Y* (*see* Fig. 1) near the top of the flowmeter scale, avoiding any position giving marked fluctuation of the float. Fix a scale graduated in millimetres behind the manometer and adjust the zero mark to coincide with the meniscus of the liquid. Then condition and weigh out according to the procedure described in **5** and **6**, 1·5 g specimens of each sample of reference sliver and test according to the procedure described in **7**, noting the distance in millimetres below the zero to which the meniscus falls. Do not clean the sliver before test. Test three specimens from each of the eight reference slivers in this way and calculate the average of the nine readings for each reference sliver.

A-3.1.1 Plot the average depression h in millimetres of the manometer meniscus against the known value of fibre diameter d in microns and after inspection to ensure that the points lie about a smooth curve, fit a relation by least squares as given below. From this relation a conversion table may be prepared in microns, or a scale may be graduated in microns and fixed behind the manometer.

A-3.1.2 *Calculation of Results by the Least Squares Method* — The relation between d and h is of the form hd^b = constant and it is thus necessary to take logarithms to obtain a linear relation.

Let $X = \log d$ and $Y = \log h$.

For each of the n lots of sliver used for standardization two values X_i and Y_i are obtained.

First calculate the following quantities:

$$\Sigma X = X_1 + X_2 + \ldots + X_n; \qquad \Sigma Y = Y_1 + Y_2 + \ldots + Y_n$$

$$\Sigma Y^2 = Y_1^2 + Y_2^2 + \ldots + Y_n^2$$

$$\Sigma XY = X_1Y_1 + X_2Y_2 + \ldots + X_nY_n$$

$$\Sigma y^2 = \Sigma Y^2 - \frac{(\Sigma Y)^2}{n}$$

$$\Sigma xy = \Sigma XY - (\Sigma X \Sigma Y)/n$$

$$b = \Sigma xy / \Sigma y^2$$

The regression equation of X and Y which applies to the apparatus is then

$$X = \Sigma X/n + b\,(Y - \Sigma Y/n) \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

A-3.1.2.1 Finally construct a table h to d by taking values of h at 5 mm intervals, finding log h, substituting in equation (1) to obtain X and so tabulating d = antilog X for each value of h.

A-3.2 Constant Pressure Apparatus — Make a horizontal mark at a distance corresponding to 180 mm water pressure from the zero mark of the manometer. Fix a scale graduated in millimetres behind the flowmeter (F) so that the zero of this scale coincides with a file mark (zero) made near the bottom of the flowmeter. Condition and weigh out 2·5 g specimens of each sample of reference sliver according to the procedure described in **5** and **6** and test according to the procedure described in **7**, noting the distance y in millimetres of the float of the flowmeter from zero. Do not clean the slivers before test. Test three specimens from each of eight (n) reference slivers in this way and calculate the average of the nine readings for each reference sliver.

A-3.2.1 Plot the average reading in millimetres, y_1, y_2, etc, against the known values of fibre diameter d_1, d_2, etc. Fit a second degree regression line of y on d. This is done by finding the coefficients a, b, c, in the equation

$$y = a + bd + cd^2 \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (2)$$

by solving the equations

$$\Sigma y = na + b\Sigma d + c\Sigma d^2$$

$$\Sigma dy = a\Sigma d + b\Sigma d^2 + c\Sigma d^3$$

$$\Sigma d^2 y = a\Sigma d^2 + b\Sigma d^3 + c\Sigma d^4$$

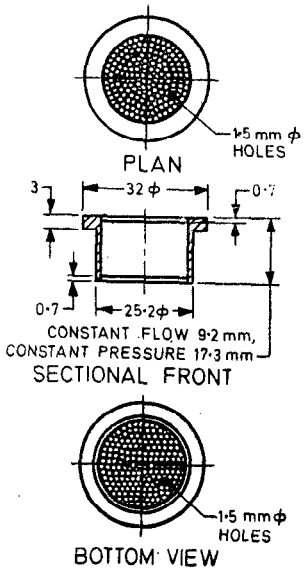
The equation (2) is then used to graduate a scale in microns which may be fixed behind the flowmeter.

A-3.3 Orifice Plate Checks — To make regular daily checks that the apparatus is in good order, the use of the two orifice plates is recommended. These consist of aluminium discs of the same diameter as the inside of the constant volume chamber, each with a central hole. The discs have a rim which in use rests on the annular top of the constant volume chamber. The diameter of the central hole in one disc is chosen to give a reading of about one-third of the available scale on the manometer (constant flow method) of flowmeter (constant pressure method) when clamped and used in the apparatus under working conditions, with no fibres in the chamber. The diameter of the central hole in the second disc is chosen to give a reading of about two-thirds of the available scale, under the above described conditions.

A-3.3.1 At least once a day orifice plates are clamped in the apparatus so that air enters through the central hole only and the readings are noted. Variations in the readings given by the scale should not exceed 2 mm and 4 mm respectively for the two orifice plates. This provides a useful and quick check on the functioning of the apparatus, particularly as regards the presence of air bubbles in the manometer system.

A-3.4 Correction Plugs — A combined correction for both temperature and barometric pressure may be made by the aid of a plug filled with non-hygroscopic fibre, for example, polyester. Details of the construction are given in Fig. 4. The plug is filled with the correct mass* of non-hygroscopic fibre and the top of the plug sealed permanently with a resin which sets at a sufficiently low temperature to avoid damaging the fibres, (for example, 100°C). The plug is clamped in place of the metal plunger on the airflow apparatus and the instrument reading taken several times at 27°C when the barometric pressure is within 5 mm Hg of the pressure at calibration. Let the mean reading be C (microns). During any series of subsequent tests the plug is inserted and a reading taken. Let this be T (microns). Then the results of any tests are multiplied by the factor C/T.

*The correct mass of non-hygroscopic fibre in grammes is given by $1{\cdot}5\rho/1{\cdot}31$ for constant flow and $2{\cdot}5\rho/1{\cdot}31$ for constant pressure where ρ = density of fibre and density of wool assumed to be 1·31. For polyester the correct mass will be 1·58 g for constant flow and 2·63 g for constant pressure.



NOTE — A thin rubber or plastic sealing ring of internal diameter 25·2 mm is placed under the rim of the plug so there is no edge leakage when clamped in position on the constant volume chamber.

All dimensions in millimetres.

FIG. 4 DIMENSIONS OF CORRECTION PLUG

A-3.4.1 With long usage of the plug, dirt deposits and the reading of the plug changes. It is advised, therefore, that after it has been used about 400 times (18 months if used once per day) the non-hygroscopic fibre be replaced by clean fibre and a new standard reading for the plug be determined. Likewise the plug shall be kept in a protective container when not in use and should be discarded if it has been in contact with any liquid, powder, etc.

APPENDIX B

(*Clause* 5.2)

CORRECTION FOR RELATIVE HUMIDITY

B-1. If tests are carried out in non-standard atmosphere of known relative humidity the results in microns may be corrected by the following

factors, applicable to fibre diameters between 19 and 37 microns:

Relative Humidity Percent	*Multiplier to Convert to 65 Percent Relative Humidity*
40	1·022
45	1·019
50	1·015
55	1·010
60	1·005
65	1·000
70	0 995
75	0·988
80	0·980
85	0·969

APPENDIX C

(*Clause* A-2.1)

REFERENCE SLIVERS FOR CALIBRATION

C-1. For calibration of the airflow apparatus as described in Appendix A, laboratory samples of eight reference slivers are available.

The fibre diameter of each sliver has been measured by the projection microscope in several laboratories and is known accurately.

The slivers are available in two forms:

a) Dry-combed, fatty matter content less than 1 percent; and

b) Oil-combed, fatty matter content between 3 and 4 percent.

A set of eight reference slivers can be obtained by appropriate laboratories on application to:

Interwoollabs
24, rue Montoyer
1 040 Brussels
Belgium

All such applications should state whether oil-combed or dry-combed slivers are required, and whether specimen masses of 1·5 g or 2·5 g are required.

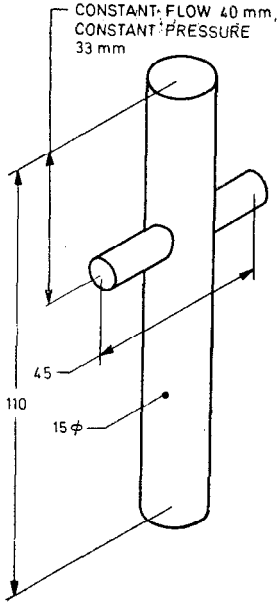
APPENDIX D

(*Clause* 3.2.8)

PACKING ROD

D-1. It is possible for operators to exert an unduly large force during packing if a rod of small diameter is used to compress the fibres in the constant volume chamber. To avoid this, the packing rod illustrated in Fig. 5 should always be used. The operator holds the rod by the long end and uses the short end to press the fibres into the constant volume chamber. The cross piece prevents the rod penetrating too far into the constant volume chamber.

The rod should be made from a non-metallic substance, for example, polythene, to minimize wear on the constant volume chamber.



All dimensions in millimetres.

FIG. 5 PACKING ROD

INDIAN STANDARDS

ON

PHYSICAL METHODS OF TEST FOR TEXTILES

IS:

681-1964	Methods for determination of universal count of woollen and worsted yarn
744-1966	Method for determination of wool fibre diameter — Projection microscope method (*first revision*)
832-1964	Method for determination of twist in yarn
1348-1971	Method for determination of kemp content of raw wool (*first revision*)
1377-1971	Method for determination of mean fibre length of wool (*first revision*)
1670-1970	Method for determination of breaking load, elongation at break and tenacity of yarns (*first revision*)
1671-1960	Method for determination of skein breaking load (strength), tenacity and yarn strength index of cotton yarn (by constant-rate-of-traverse machine) (metric system)
1954-1969	Methods for determination of length and width of fabrics (*first revision*)
1963-1969	Methods for determination of threads per decimetre in woven fabrics (*first revision*)
1964-1970	Methods for determination of weight per square metre and weight per linear metre of fabrics (*first revision*)
1966-1961	Methods for determination of bursting strength of woven and knitted fabrics
1969-1968	Method for determination of breaking load and elongation at break of woven textile fabrics (*first revision*)
2702-1965	Method for determination of thermal resistance of textile fabrics, guarded hot-plate method
2899-1965	Method for determination of percentage of medullated fibres in wool
4681-1968	Method for determination of wrinkle recovery of fabrics (by measuring crease recovery angle)
4902-1968	Method for determination of correct invoice weight and moisture content of woollen and worsted yarns
6124-1971	Method for determination of crimp in wool

PUBLICATIONS OF INDIAN STANDARDS INSTITUTION

INDIAN STANDARDS

Over 7 000 Indian Standards covering various subjects have been issued so far. Of these, the standards belonging to the Textile Group fall under the following categories:

Aeronautical textiles
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